Monitoring Progress Toward a CVPIA Recovery Objective: Estimating White Sturgeon Abundance by Age

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Introduction

The Central Valley Project Improvement Act (CVPIA) objective of a sustained increase in the number of age-15 white sturgeon to 11,000 is the only quantitative management objective for white sturgeon in California. The California Department of Fish and Wildlife monitors progress toward the objective by using routine abundance estimates from a mark-recapture study and — because routine aging of sturgeon has not been funded — an age-length key to assign ages to fish captured during tagging.

We've previously described the routine abundance estimates as coming from a complicated algorithm that includes periodic updates with recapture data collected up to several years after tagging, assumptions about growth rate and about mortality attributable to tagging, and more professional judgment than we'd like (DuBois et al 2011). In an effort to speed the production of abundance estimates and perhaps improve the accuracy of abundances estimates, we are taking a number of steps. One key step was development of an alternative method of estimating the abundance of legally-harvestable white sturgeon (DuBois and Gingras 2011) that uses estimates of harvest rate, uses harvest data from Sturgeon Fishing Report Cards (Report Cards), and can be finalized relatively quickly. White sturgeon 46-66" Total Length (TL) were legal to harvest February 28, 2007-December 31, 2012, and white sturgeon 40-60" Fork Length have been legal to harvest since January 1, 2013.

Another key step is assessing the degree to which the age-specific abundance estimates are biased due to selectivity of the (trammel) nets used to capture fish during tagging, when tagging occurs, where tagging occurs, and how many fish are sampled. The nets have been standardized for many years and include panels of 3 different mesh sizes (DuBois et al 2012), and tagging occurs August-October in San Pablo Bay and/or Suisun Bay. It's plausible that the length distribution of fish caught during tagging is not representative of the true length distribution, and if so that abundance estimates made using the age-length key are inaccurate and possibly biased as a result.

Here we compare and contrast age-specific estimates of 117-168 cm TL (i.e., 46-66" TL) white sturgeon abundance using length frequency data from tagging and from Report Cards, the alternative method of abundance estimation, and an age-length key. Anglers are required by CCR Title 14 Sections 5.79 and 27.92 to report lengths of harvested white sturgeon on Report Cards and to submit Report Cards by January 31 of the following year. Use of the length dataset from Report Cards for the present purpose is intuitively appealing because it contains more white sturgeon lengths per year than the tagging dataset and any other dataset.

Investigation

We used 2007-2011 abundance estimates for fish 117-168 cm TL (Range: ~35,000-57,000 fish) calculated using harvest records (Report Card data) and harvest rates (mark-recapture data; DuBois and Gingras 2011).

We used 2007-2011 lengths of fish reported by anglers as kept (N = 8,491) and lengths of fish 117-168 cm TL caught during tagging for the Department's mark-recapture study (N = 1,518).

We calculated each estimate of annual age-specific abundance using the age-length key (Table 1) and the following algorithm: (1) Bin the lengths, then (2) multiply the number of fish per bin by the historic fraction of the age distribution from that bin and sum (column-wise) those products, then (3) divide the number of fish at each age by the total number of fish lengths, and then (4) multiply the estimates of white sturgeon 117-168 cm TL abundance by the fraction of fish at each age. The historic fraction of age at length is from data in Kohlhorst et al. (1980). Note from Table 1 that all or nearly all fish aged 12-16 are 117-168 cm TL.

Table 2 shows estimated abundance using length frequency data from tagging and from Report Cards. The estimates are notably low (range 373-7240; Avg 3330) and — due to recruitment to and from the 117-168 cm TL length range as well as relative imprecision of the estimates — do not clearly show the expected reduction in abundance for each cohort attributable to natural mortality and harvest.

Figure 1 is a scatter plot of annual estimates of abundance for each brood year using length frequency data from Report Cards versus from tagging, and shows strong correlations (R-squared range 0.8013-0.9752 and Avg 0.910) and slopes consistently slightly less than 1 (Range 0.8323-0.9833 and Avg 0.935). The slopes suggest that one or the other sets of length data is biased.

Figure 2 is the ratio (Range 0.45-1.73%; Avg 1.02%) between abundance estimates for each age using the two sets of length data (e.g., 867 age-8 fish in 2007 from tagging divided by 724 age-8 fish in 2007 from Report Cards), and shows both that declining trends with age are typical and that the greatest differences in ratio occur among estimates for relatively young fish and for relatively old fish. The slopes suggest that one or the other sets of length data is biased, and the range of ratios per age suggests similar distributions of lengths near the middle of the length range in both datasets.

Discussion

From our brief investigation, it's clear that the selection of length frequency distribution is important when using length frequencies to estimate the age-specific abundance of white sturgeon.

Length frequency distributions from Report Cards are affected by whatever selectivity anglers apply (e.g., hook size; 'high grading' through catch-and-release), but we suspect and have been repeatedly told by anglers that selectivity is low because the legal size limit is narrow (presently 40-60 inches Fork Length) and catch rates are low (e.g., <3 fish per 100 hours effort (DuBois et al 2011)). We suspect that abundance estimates made using lengths from Report Cards are more accurate than those made using lengths from tagging, because anglers fish throughout the year and throughout the range of white sturgeon, use a variety of angling techniques, and use a variety of angling gear — whereas catch during tagging is substantially constrained by seasonal, location, and gear requirements.

Estimates of 117-168 cm TL white sturgeon abundance using harvest rate (from mark-recapture) and harvest records (from Report Cards) can be developed more quickly and are more precise than routine mark-recapture estimates, lengths from Report Cards are likely representative of the true length distribution, and essentially all age-15 white sturgeon are 117-168 cm TL. For those reasons, we recommend that progress toward CVPIA's recovery goal of 11,000 age-15 white sturgeon be monitored using those data and that approach.

NOTE TO MANAGERS: The CVPIA objective of a *sustained increase* in the number of age-15 white sturgeon to 11,000 has not been achieved approximately 2 decades after being established (DuBois and Gingras 2011). From our work here on the estimation of white sturgeon abundance, from work to index young-of-the-year white sturgeon abundance (Fish 2010; CDFW 2013), and from work to relate the

relative abundance of white sturgeon to Delta outflow (Fish 2010), it is likely that the number of age-15 white sturgeon will not increase to 11,000 for at least another 5 years and it is nearly certain that there will be no sustained increase in the number of age-15 white sturgeon without substantial reduction of harvest, hatchery augmentation, major improvement in fish passage (e.g., re-watering the San Joaquin; dam removal), and/or beneficial climate change.

References

CDFW. 2013. Figure: Index of Annual White Sturgeon Production, 1980-2012. Available at: https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentId=69133

DuBois J, M Gingras. 2011. Using Harvest Rate and Harvest to Estimate White Sturgeon Abundance. Interagency Ecological Program for the San Francisco Estuary Newsletter 24(3):23-26.

DuBois J, M Gingras, G Aasen. 2011. Status and Trends of San Francisco Estuary White Sturgeon. Interagency Ecological Program for the San Francisco Estuary Newsletter 24(1):50-55.

DuBois J, T MacColl, MD Harris (California Department of Fish and Wildlife). 2012. 2012 Field Season Summary for the Adult Sturgeon Population Study. Stockton, California. 10 p.

Fish MA. 2010. A white sturgeon year-class index for the San Francisco Estuary and its relation to delta outflow. Interagency Ecological Program for the San Francisco Estuary Newsletter 23(2): 80-84

Kohlhorst DW, Miller LW, Orsi JJ. 1980. Age and growth of white sturgeon collected in the Sacramento-San Joaquin Estuary, California: 1965-1970 and 1973-1976. California Fish and Game 66(2):83-95.

Table 1 White sturgeon age-length key (data in Kohlhorst et al. 1980); note: dashed line contains data on fish within legal slot limit; ages 0-6 and bins 21-91 omitted for formatting purposes

Table 2 White sturgeon abundance estimates by age (8-21) using Report Card data and tagging data (2007-2011)

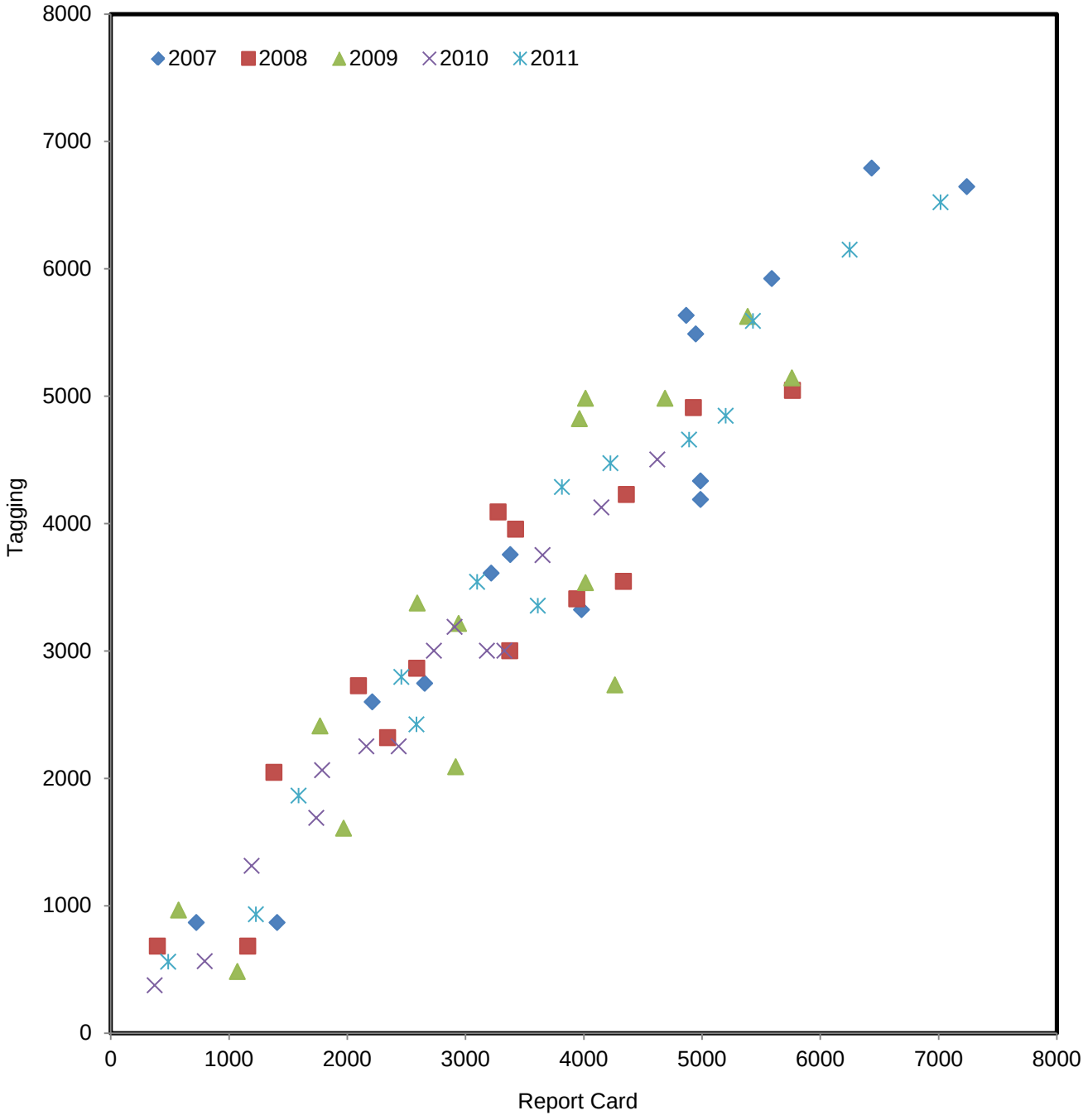
Figure 1 Scatterplot comparing estimates of white sturgeon abundance at age from Report Card data and from tagging data (2007-2011)

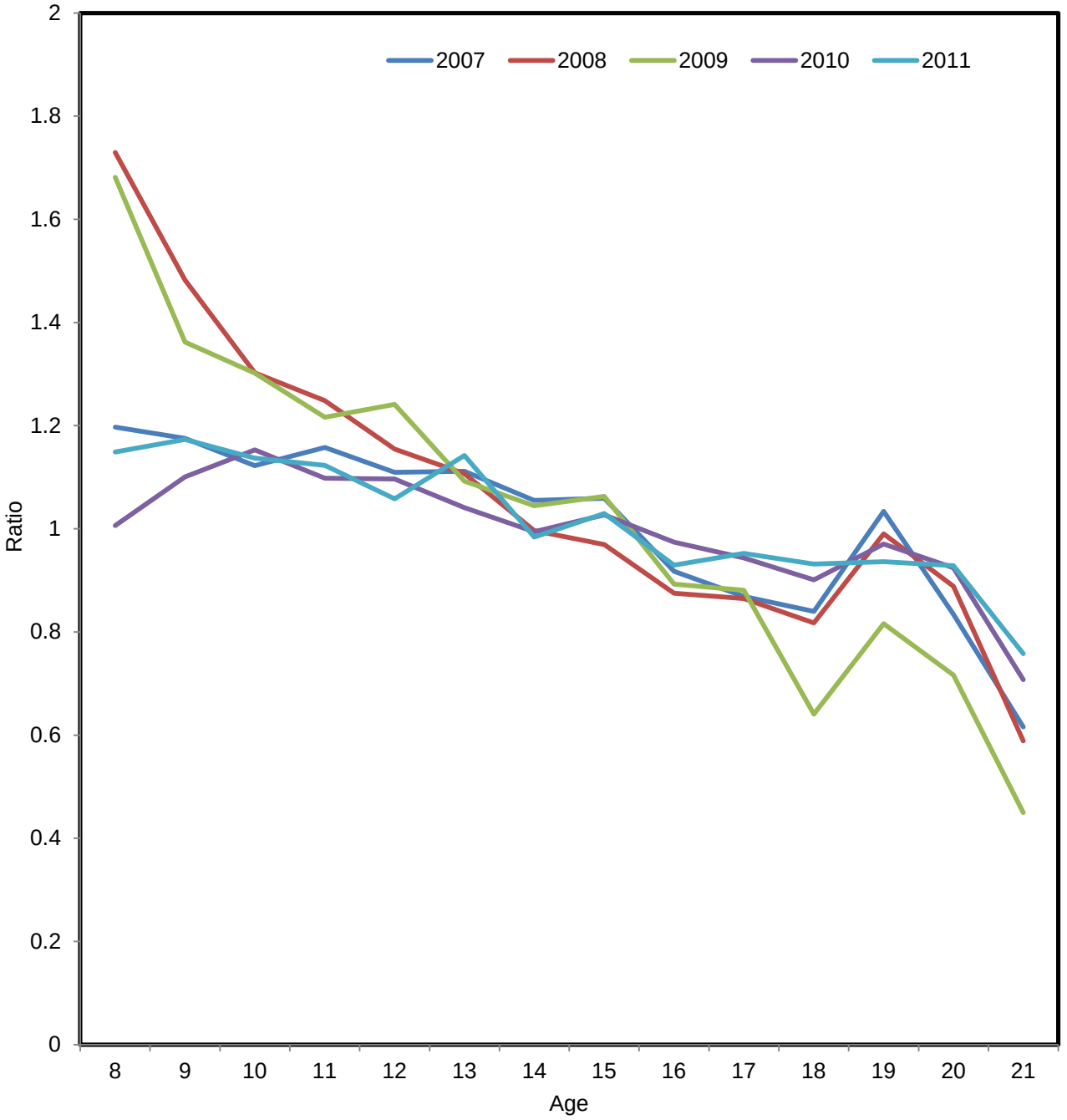
Figure 2 Ratio (tagging data/Card data) of white sturgeon estimates (2007-2011) at age (8-21)

Bins (cm TL)	White Sturgeon Ages									
	7	8	9	10	11	12	13	14	15	16
96-100	0.2568	0.3108	0.2838	0.0811	0.0135	0	0	0	0	0
101-105	0.2281	0.1842	0.307	0.1579	0.0702	0	0	0	0	0
106-110	0.0571	0.2143	0.3	0.2429	0.1	0.0286	0.0286	0	0	0
111-115	0	0.1186	0.3051	0.4237	0.1017	0.0169	0.0339	0	0	0
116-120	0	0.1136	0.1818	0.1818	0.1591	0.1591	0.0455	0.0909	0.0455	0.0227
121-125	0	0	0.0833	0.1111	0.1944	0.1389	0.1389	0.1389	0.1667	0.0278
126-130	0	0	0.0541	0.0811	0.2162	0.1351	0.0541	0.1622	0.0541	0.0811
131-135	0	0	0	0.0882	0.1176	0.1471	0.1176	0.0294	0.1176	0.1471
136-140	0	0	0	0	0	0.1154	0	0.2308	0.1538	0.2308
141-145	0	0	0	0	0	0.0286	0.0571	0.1429	0.1429	0.2286
146-150	0	0	0	0	0	0.027	0.1081	0.1622	0.1622	0.1351
151-155	0	0	0	0	0	0	0.0435	0.1304	0.087	0.087
156-160	0	0	0	0	0	0	0	0.0769	0.0769	0.1538
161-165	0	0	0	0	0	0	0	0	0	0.25
166-170	0	0	0	0	0	0	0	0	0	0.125
171-175	0	0	0	0	0	0	0	0	0	0.125
176-180	0	0	0	0	0	0	0	0	0	0
181-185	0	0	0	0	0	0	0	0	0	0
>185	0	0	0	0	0	0	0	0	0	0

17	18	19	20	21	22
0	0	0	0	0	0
0	0	0	0	0	0
0	0	0	0	0	0
0	0	0	0	0	0
0	0	0	0	0	0
0	0	0	0	0	0
0.0811	0.027	0.027	0.027	0	0
0.1176	0.0294	0	0.0882	0	0
0.1538	0.0385	0.0769	0	0	0
0.1714	0.1143	0	0.0857	0.0286	0
0.0541	0.1892	0.1622	0	0	0
0.1304	0.3478	0	0.087	0.087	0
0.0769	0.1538	0.0769	0.3077	0	0.0769
0.1667	0.1667	0.0833	0.1667	0.1667	0
0	0.125	0.5	0.25	0	0
0.25	0.25	0.375	0	0	0
0	0.1667	0.1667	0.3333	0.1667	0.1667
0	0.3333	0	0.3333	0	0.3333
0	0	0	0.75	0	0.25

Age	Report Card					Tagging				
	2007	2008	2009	2010	2011	2007	2008	2009	2010	2011
8	724	394	573	373	487	867	682	964	375	559
9	2,212	1,380	1,770	1,193	1,588	2,600	2,045	2,411	1,313	1,863
10	3,218	2,094	2,593	1,789	2,459	3,611	2,727	3,375	2,063	2,795
11	4,867	3,277	3,965	2,734	3,817	5,633	4,091	4,822	3,001	4,286
12	4,947	3,425	4,014	2,908	4,226	5,489	3,955	4,983	3,189	4,472
13	3,379	2,587	2,942	2,162	3,099	3,756	2,864	3,215	2,251	3,541
14	6,435	4,928	5,386	4,150	6,250	6,789	4,909	5,625	4,127	6,149
15	5,591	4,361	4,688	3,653	5,430	5,922	4,227	4,983	3,752	5,590
16	7,240	5,766	5,760	4,622	7,018	6,645	5,045	5,143	4,502	6,522
17	4,987	3,942	4,014	3,181	4,892	4,333	3,409	3,536	3,001	4,659
18	4,987	4,337	4,264	3,330	5,200	4,189	3,545	2,732	3,001	4,845
19	2,655	2,341	1,970	1,740	2,587	2,744	2,318	1,607	1,688	2,422
20	3,982	3,376	2,917	2,435	3,612	3,322	3,000	2,089	2,251	3,354
21	1,408	1,158	1,072	795	1,229	867	682	482	563	932


2007
2008
2009
2010
2011
Tagging
Report Card
0
1000
2000
3000
4000
5000
6000
7000
8000


2007
2008
2009
2010
2011
Ratio
Age
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
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11
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